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THE PERIOD OF SAFE PLANT GROWTH IN MARYLAND AND DELAWARE*

By OLIVER L. FASSIG

It is customary to establish the period of safe plant growth for a locality by determining the average dates of the last killing frost in spring and the first killing frost in fall, for the locality in question; the length of the intervening period may be regarded as the mean frostless period. When a temperature of 32° or below occurs without the occurrence of frost during a critical period after plant activity has begun in the spring, or in the early fall before the crops have all been gathered, the date of occurrence of the last and first temperature of 32°, respectively, is substituted in place of a killing frost in determining the average dates of the last and first frosts. The occurrence of frost does not generally coincide with the occurrence of a temperature of 32°, owing to the custom of exposing the thermometer in a shelter several feet above the ground. The difference between the temperature upon the ground and the temperature within the shelter, about five feet above the ground, may be as much as 10°, the degree of variation depending upon the topography and the weather conditions. As a rule the temperature at the ground is distinctly lower during the night hours than the temperature in the shelter; this condition may be reversed, however. Since the frostless periods based on the last and first occurrence of frost and on the last and first occurrence of a temperature of 32° are not of equal length, the usual method of calculating this period from records made up of both kinds of observations is obviously open to criticism. The use of an occasional freezing temperature to complete a long record of observed frosts is not objectionable, but a frequent substitution should not be resorted to.

In order to learn the extent of the difference in the length of the frostless period, or rather the difference in the length of the period of safe plant growth as determined by means of the two methods described, two distinct series of observations were tabulated and compared for all stations in Maryland and Delaware having a record covering a period of ten years or more. Fortunately, we have in these states a large number of carefully made observations extending over periods varying from ten years to forty-three years. The average length of these records is twenty years, confined mostly to the period from 1890 to 1913. The accompanying table [shown by Mr. Fassig] exhibits the following facts of importance in making a comparison of the two methods of determining the frostless period:

1. The location of all stations having a record of ten or more years.
2. The length of each record.
3. The average date of the last and first killing frost.
4. The average date of the last and first temperature of 32°.
5. The average length of the intervening periods.
6. The average difference in the length of the two periods.

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* Abstract of a paper read at the joint meeting of the American Geographical Society and the Association of American Geographers in New York City, on April 3, 1914. Illustrated by charts.

The tabulated results have also been charted, bringing out more clearly the geographical differences in the length of the periods as determined by the two methods of calculation.

The accompanying table and charts† are interesting and instructive and suggest the advisability of adopting a uniform method of determining the period of safe plant growth, and they also appear to demonstrate the superiority of the method based upon the last and first occurrence of a fixed temperature, for example 32°, over the usual method of observing and recording the dates of the last and first killing frosts in spring and fall, respectively.

Some of the reasons which may be advanced in favor of the method of determining the period from the temperature records are the following:

1. The temperature is observed and recorded regularly, and the record is therefore complete for the entire season.
2. Frost records are apt to be incomplete unless they occur at critical periods in plant growth. This failure to record frosts is particularly noticeable in records of spring frosts; stations having excellent fall records have often a very defective record of spring frosts. Frosts occurring after a long period of warm weather, as in summer or early fall, are likely to be more conspicuous events than the last of a series of many frosts occurring throughout the winter and early spring.
3. In recording frosts there is always a variable personal factor, opinions differing as to the extent and severity of the frost, resulting in the same frost being designated as heavy or killing. In recording temperatures, on the other hand, this personal factor is practically eliminated.
4. There is a fairly fixed and uniform relation existing between the temperature in the shelter and the occurrence of a killing frost in any given locality, and this factor can be readily determined from a comparatively short series of observations.
5. For reasons stated above a reliable "frostless period" may be established for a given locality from a shorter series of observations by the use of a temperature record than by the use of a frost record.

The Maryland and Delaware records, covering an average period of twenty years at fifty stations, show that the frostless period based on the observations of a temperature of 32° is about ten days longer than the period based on the occurrence of killing frosts. This relation holds good for stations in open level places, but apparently does not hold for stations in the mountain districts, where the period based on the occurrence of frosts is about ten days longer than that determined from a record of freezing temperatures in a shelter five feet above the ground.

The necessity of charting these two systems of observations separately is apparent, and I am convinced that the method of temperature observations is the better method. The formation of frost depends not only upon the occurrence of a temperature of 32° or lower, but also upon the relative humidity of the air at the time and place of formation; the temperature may fall considerably below the freezing point for water without the occurrence of frost, in a dry atmosphere. The injury to plants is probably as great in one case as in the other, yet the absence of frost may give the impression that no injury has resulted.

A comparison of the charted results of the two methods shows a similar configuration of the lines of equal frostless periods and of lines showing the beginning and ending of the periods, but the charts based upon the temperature records show greater detail owing to the use of the greater number of stations and the greater average length of the periods of observation permitted by the temperature method.

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† Only one of the charts is shown here.

Nearly all of the temperature observations used in the construction of the accompanying chart were made under similar methods of exposure of thermometers—namely, in standard Weather Bureau shelters, about five feet above the ground, in country districts, or in open places in small towns. Proper allowance must be made for temperatures observed under conditions which differ widely from the usual methods of exposure, such as those made in large cities, like Baltimore and Washington, where the thermometers are exposed upon the roofs of buildings at elevations of 100 feet or more above the ground.

The charts show quantitively what has long been recognized in a general way, namely, the great influence of Chesapeake Bay in lengthening the period of safe plant growth in Maryland. This fact is conspicuous in all the charts.

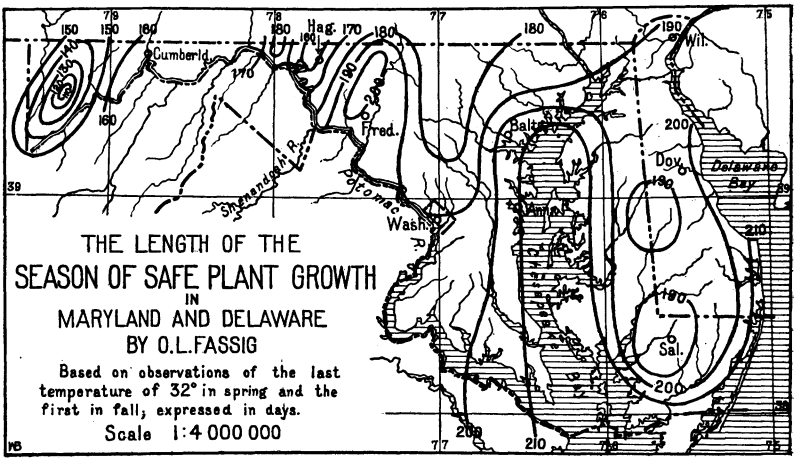

Fig. 1.

The protecting influence of the mountains in the western part of Maryland is also clearly shown in the greater length of the frostless period on the eastern, or leeward side, and in the contrast between conditions on the western and eastern sides of the Blue Ridge Mountains in Washington and Frederick Counties.

The length of the period of safe plant growth along Chesapeake Bay in southern Maryland is longer by nearly 100 days than the period in Garrett County in the mountains of western Maryland.

Taking the average for a long series of years a temperature of 32° or below disappears for the season along the shores of Chesapeake Bay and along the Atlantic coast about April 5; and again makes its appearance in the fall about November 10 or 12, showing a period of safe plant growth of about 210 days. These figures apply, however, only to localities near the shore, the length of the period diminishing rather rapidly with the distance from the water's edge. This protecting influence of the bay is strikingly brought out in the chart, showing the variations in the length of the frostless period on what is known as the ''Peninsula''—the district in Maryland between the Atlantic Ocean and Chesapeake Bay. In the central portions of the Peninsula, farthest away from the bay and the ocean, regions in which nocturnal radiation is more active than in the immediate vicinity of large bodies of water, freezing temperatures do not usually disappear in the spring until April 15 to 20, and reappear in the fall about October 20 to 25, decreasing the period of safe plant growth from 210 days near the shores to 190 days at distances only twenty to twenty-five miles inland, a difference of twenty days.

In the mountain districts of the Blue Ridge we have a striking example of the protecting influence of a mountain range stretching across the path of the prevailing westerly winds. On the western, or windward side of the Blue Ridge, in the lower levels of the Cumberland Valley, the frost period extends into the first week of May and reappears in the fall in the first decade of October, showing a period of safe plant growth of about 160 days; on the eastern, or protected side, of the Ridge the period is lengthened to 190 days, and even 200 days, the freezing temperatures disappearing about April 15 and reappearing in the third decade of October. In the mountain districts the variations in the length of the season are to some extent due to cold air drainage during clear and calm nights, and cannot be altogether attributed to the protecting influence of the mountains against the cold westerly winds.

In the most western county of Maryland we find another factor entering into the length of the period of safe plant growth, namely, that of elevation. The general level of Garrett County is not far from 2,500 feet above sea-level, with peaks rising to 3,000 feet. Here we have a very decided shortening of the period, injurious frosts extending into the early days of June, and appearing again about the middle of September, showing a period of safe plant growth of but little more than 100 days in the areas exposed to intense nocturnal radiation and to extensive air drainage.

The dates and figures quoted, it should be kept in mind, are average values, based upon a long series of years of carefully made observations. The variations from these average or normal values from year to year are of course large, and the extent of variability from the normal dates of occurrence of the last killing frost or frost temperature in spring and the first in fall is a very important factor of the climate of any given locality. A further study of this matter will be made later; the primary purpose of this paper is the determination of the best method of calculating the period of safe plant growth, and the normal length of the period in the states of Maryland and Delaware.